[13489/1]

FLOATING SOLAR CHIMNEY

The invention concerns solar chimney that can collaborate with solar collectors and wind turbo generators and form electric power stations working by solar power. Such conventional electric power systems using solar energy, with the method of solar collectors and solar chimneys, are based on the principle of solar heating of air in a solar collector of a large area. The warm air is up-drafting, through a collaborating solar chimney that is based on the center of the collector, to superior layers of atmosphere, acquiring updraft speed, due to the height of the solar chimneys. Part of the thermo mechanical energy of this up drafting current of warm air, via a system of the wind turbines and generators in the base of the solar chimney, transforms into electric energy. The solar chimney in this conventional system is manufactured by reinforced concrete. This has the following consequences:

- High manufacturing cost
- Limited height of the solar chimneys due to technological restrictions from the construction materials and from exterior limitations (earthquakes e.g.)

It is known that the output of such a power station is approximately proportional to the product of the height of solar chimney to the area of the collaborating solar collector. Thus for a given power output from such a solar power station the height of the solar chimney determines the area of its collaborating solar collector.

Information about solar chimneys can be found in the book "THE SOLAR CHIMNEY ELECTRICITY FROM THE SUN", by JORG SCHLAICH, 1995.

The proposed invention aims to eliminate all pre-mentioned disadvantages by increasing, for a given power output, the height of the solar chimney

and decreasing their construction cost and the area of the solar collectors and therefore the total cost of the respective power plant of electricity.

This can be achieved if we construct the solar chimney a double wall from durable elastic of balloons or airships, filled with gas He (or other non flammable light gas) that makes the chimneys lighter than air. The lighter than air floating solar chimney can have much bigger height than the corresponding solar chimney from reinforced concrete, while simultaneously its costsremains considerably lower than the cost of a conventional chimney from reinforced concrete.

The construction of a floating lighter than air chimney is feasible taking into consideration that the solar chimney is used exclusively for the up-drafting of warm air. Thus solar chimney stresses arise from the exterior winds and the Bernoulli pressure from the internal stream of warm air. A clever, simple and inexpensive construction can face these stresses effectively. The modem plastic and composed materials that are used for airships or balloons can be used for such a construction combining light weight and high strength in extreme stresses with long life under any exterior conditions.

The advantages of the proposed invention are very important and indicatively but not exclusively are as follows:

- The height of the floating solar chimney can be unlimitedly increased up to some optimal height that will be determined by the materials, technology and cost.

- The construction cost of the floating solar chimney will be considerably lower than the cost of a conventional reinforced concrete chimney.

- The cross-section of the floating solar chimney can easily be

altered with the height for the optimal operation of the solar chimney.

- The area of the collaborating solar collector will be decreased proportionally to the increase of height for the same nominal power output of the solar power station, and consecutively the construction cost of the solar collector will decrease proportionally.

- An optimal combination of the height of the floating solar chimney and the area of the solar collector can be chosen for the achievement of the optimal techno economical result.

- Seismic activity of the region does not influence the construction.

Hence the proposed invention could make the electrical power solar stations with floating solar chimneys economically competitive to other electrical power stations per kW of power of kWh of produced energy.

The proposed floating solar chimney is based on the seat (1.4) shown in figure 1a:

- The Main Chimney (1.1) is composed by parts. This has double wall filled with lighter than air inflammable gas that creates the necessary buoyancy force. This lifting force compels the main chimney to take, without exterior winds, a vertical position.

- The Heavy Mobile Base (1.2) by which the main chimney is suspended. The total weight of this heavy base is bigger than the total buoyancy of the main chimney. This has a result, without exterior winds, the heavy mobile base to sit on the seat (1.4) of the chimney.

- The folding lower part of the chimney (1.3) which without exterior winds is inside the upper part of the seat.

If exterior winds appear the main chimney (1.1) declines to a balance angle. The heavy base (1.2) supported in the edges of the seat receives also a corresponding declined position and the folding part of the chimney (1.3) that is fixed in the lower part of the Heavy Base, is lifted off and receives this decline, ensuring the continuity of the chimney as it appears in figure 1b.

An indicative way of constructing a floating chimney is presented in the following paragraphs. The proposed way of construction is indicative, because there are several ways in doing so. The proposed construction is based on the idea of developing the main solar chimney with horizontal balloon cylindrical rings (Ring , figure 2) from flexible wrapping of balloons or airships (with a average surface density of 0,068 kg/sqm). Each cylindrical balloon ring D1 is filled with gas He (that gives a lifting force under regular conditions 10,36 Nt/m) or other light non flammable gas (e.g. NH3 with lift force under regular conditions 4,97 Nt/m). The ring has an orthogonal cross-section and valves of fulfillment. The dimensions of orthogonal cross-section of ring Dl depend mainly from the diameter of solar chimney. Each cylindrical ring will be separated from next from durable, in horizontal stresses, supporting ring D2 (figure 3). Rings D2 will be manufactured by pipes of hard plastic or composed materials or aluminum with suitable diameter and thickness. Hence the ring D2 supports balloon ring DI from compressive forces of deformity. The total weight of ring D2 has to be smaller than the remain lift force of the balloon ring DI. Thus each balloon ring DI will be able to lift up to any atmospheric height as part of floating solar chimney, lifting together at least one ring D2. The exterior part of ring D2 will have suitable tips for the fastening of rings, D2 between them, with the help of threads of high strength in order that intermediary balloon rings to be under pressure.

The proposed floating solar chimney is a set of independent successive parts which are constituted by a constant number of balloon rings and supporting rings D2. Each part is a compact durable set that can float due to its-buoyancy. Each part of the chimney is suspended by at least three threads of high strength by the upper part of the Heavy Mobile Base (1.2), see figure 1a.

Thus each part can receive any declined position imposed by exterior winds without problem. The successive parts of the floating chimney are separated, with a balloon ring D1, full from air from the environment which instead of valve of fulfillment, has a simple aperture or a special valve that allows air to enter and to come out depending on the relative movement of successive independent parts of chimney by variable exterior winds. With this intermediate air rings each part of the floating solar chimney becomes dynamically independent from the rests. The main floating solar chimney (1.1) is the sum of these successive and dynamically independent parts fastened independently to the Heavy Base. This set and every part of it can self float and stand the forces from the Bernoulli pressures by the internal updraft of warm air and the exterior winds. The thickness of balloon ring D1 s sufficient for the satisfactory heat insulation of the internal warm current of air that runs through the solar chimney from the exterior air that has lower temperature.

The main floating solar chimney (1.1) leads to its Heavy Mobile Base (1.2). The Heavy Mobile Base (1.2) is constituted by two rings of equal weight connected between them with exceptionally durable threads with high strength and high modulus, invested with flexible durable plastic films, so that it can receive any decline position while remains attached to the top of the seat of chimney. The total weight of the Heavy Base (1.2) exceeds the overall lift force of the main chimney and forms with this a single set. Under regular conditions the upper

ring of the Heavy Base, which is manufactured with bigger diameter than the diameter of the upper part of the seat (1.4), sits on the seat of the chimney (1.4) while the lower ring, that has smaller diameter than the internal diameter of upper part of the seat (1.4), remains inside the seat (1.4) of chimney. By the lower part of the internal ring of the Heavy Base (1.2) is suspended the final folding part (1.3) of the floating solar chimney. This folding part (1.3), type accordion, is constructed in a similar way as the main chimney, with the difference that the balloon rings that constitute it, instead of valve of fulfillment have a simple aperture (or a special valve) which allows the air of the environment to enter and to come out of them, depending on the decline of main solar chimney. The height of the folding part is calculated so that it can receive the maximum decline of the main solar chimney.

The threads of high strength and modulus, combined with the intermediate supporting rings D2, ensure the strength of this folding part to the forces that it accepts and they do not allow the deformity of its cross-section when it is declined and unfolded. This allows the smooth operation of the floating solar chimney when exterior winds appear that compel the solar chimney to receive a decline angle of balance.

If a floating solar chimney is free, without the presence of exterior winds, will have a vertical position, forced by the net lift force of main chimney's balloon rings D1, (figure 1a). The exterior winds compel the floating solar chimney to receive a decline which the heavy base follows and finally the folding part receives it, as shown in figure 1b. The angle of decline will be the one for which the normal drag force, from the vertical on the chimney component of the wind velocity, is equal to the counterbalancing component of net lift force of floating solar chimney.

In this case the dynamic field of flow of exterior winds facilitates the coming out of hot air at the top of the solar chimney, and consequently

facilitates the updraft movement of warm air inside the main chimney.

This action potentially compensates the reduction of active height of floating solar chimneys due to the decline that receives when exterior winds appear. Thus the power output by floating solar chimney can be practically independent of exterior winds.

The appropriate place of installment of this solar power station should be chosen in order that the expected local winds do not exceed some strength for safety reasons. The threads of high strength via which becomes the fastening of the rings D2 between them and the final fastening to the Heavy Base (1.2) can ensure the safe withholding of the floating solar chimney under the most unfavorable conditions of exterior winds even if these do not have practical probability to appear.

DESCRIPTION OF FIGURES

Figure 1a: Floating Solar Chimney in vertical position (without exterior winds).

1.1 Main Chimney
1.2 Heavy Mobile Base
1.3 Holding Lower Part
1.4 Chimney's Seat
1.5 (N-1) the part of the main chimney.

Figure 1b: Floating Solar Chimney in decline.

1.1 Main Chimney
1.2 Heavy Mobile Base 1
1.3 Holding Lower Part
1.4 Chimney's Seat
1.6 Vector of Direction of wind

Figure 2: Cylindrical Balloon Ring of Floating Solar Chimney (Ring Dl).

2.1 Internal Diameter of ring
2.2 Width of ring
2.3 Thickness of ring

Figure 3: Supporting Ring (ring D2).
3.1 Internal Diameter of ring D2
3.2 Width of ring D2

Note: Dimensions 2.1, 3.1 are roughly equal to the dimensions 2.2 and 3.2 respectively.

CLAIMS

1. Floating Solar Chimney (fig 1a, 1b) that is composed by three basic parts

- o The main chimney (1.1)
- o The heavy base (1.2)
- o The folding part (1.3)

The main chimney (1.1) is composed by a number of dynamically independent self floating parts. Each part of the main chimney (1.1) is composed by cylindrical balloon rings (figure 2), with material from strengthened plastic of high strength full from non flammable lighter than air gas (e.g. He, NH3). Each part can float, self lifted by the buoyancy of the cylindrical balloon-rings that compose it. The construction of each part is strengthened with intermediate supporting rings from pipes of hard plastic, or composed material or aluminum in an articulated structure (figure 3), so the floating solar chimney to withstand the compressive forces. The balloon rings (figure 2) with the help of tips that are on the supporting rings (fig 2) are tied up with threads of high strength successively so that they shape a compact part. Every compact part of the main chimney is composed by a fixed number of balloon and supporting rings and is fastened independently with at least three threads of high strength and modulus on the heavy base (1.2). Every compact part is separated from the next with a balloon ring full of air that can enter and come out freely in the environment, so that it becomes dynamically independent by his neighboring parts. The heavy base of chimney (1.2) is composed by two adjacent equally weighted rings with different exterior diameter in order that the upper to have exterior diameter bigger than the exterior diameter of chimney seat (1.4) and the lower, diameter smaller than the internal diameter of this seat. The total weight of heavy base (1.2) is bigger than the net lift force of the main chimney. The two rings of the heavy base (1.2) are tied up between them, with a sufficient number of threads having exceptionally high strength

and modulus. These threads are surrounded by a flexible plastic film of high strength that does not permit the air of solar chimney to escape between the two parts of the heavy base. The folding lower part of the floating solar chimneys (1.3) is fastened by the lower ring of the heavy base and is a flexible type accordion. It is composed by balloon rings (fig 2) and supporting rings (fig 3) as the main chimney. The balloon rings of the folding lower part are hot filled with light gas. They have suitable apertures or valves in order that the air of environment can go in and out freely from them. Thus this folding part can be bent and receive the decline that will receive the main chimney and the heavy base, under the influence of exterior winds, ensuring the continuity of the solar chimney (fig 1b).

2. Floating solar chimney according to claim 1 which is characterized by the fact that is manufactured with double walls from light durable material full with non flammable light gas (e.g. He NH3, etc.) and which can self lifted and be flexible so that it can stand and face successfully the forces from exterior winds and Bernoulli sub pressure forces from the updraft of warm air that flows through it.

ABSTRACT

The floating solar chimney is composed by three parts as appear in figure 1(a). The Main Chimney (1.1). The Heavy Base (1.2). The Folding Lower Part (1.3). The main chimney (1.1) is composed by cylindrical balloon rings D1 (fig 2) full of non flammable light gas. This cylindrical balloon rings D1 are tied up between them with the help of supporting rings D2 (fig 3) so that they form a compact thermo insulated cylindrical chimney. The compact parts of the main chimney are fastened on the mobile heavy base. The successive compact parts are separated with rings D1 full from environmental air that can go in and out, so that the dynamic independence of the successive parts is ensured. The main chimney can float; self lifted and is fastened on the seat (1.4) by the mobile heavy base (1.2). In the lower part of its heavy base is fastened the folding lower part of solar chimney (type accordion, 1.3). The air can enter and come out freely from the rings of folding lower part in order that the floating solar chimney can receive any suitable decline in order to withstand the exterior winds (fig 1b).

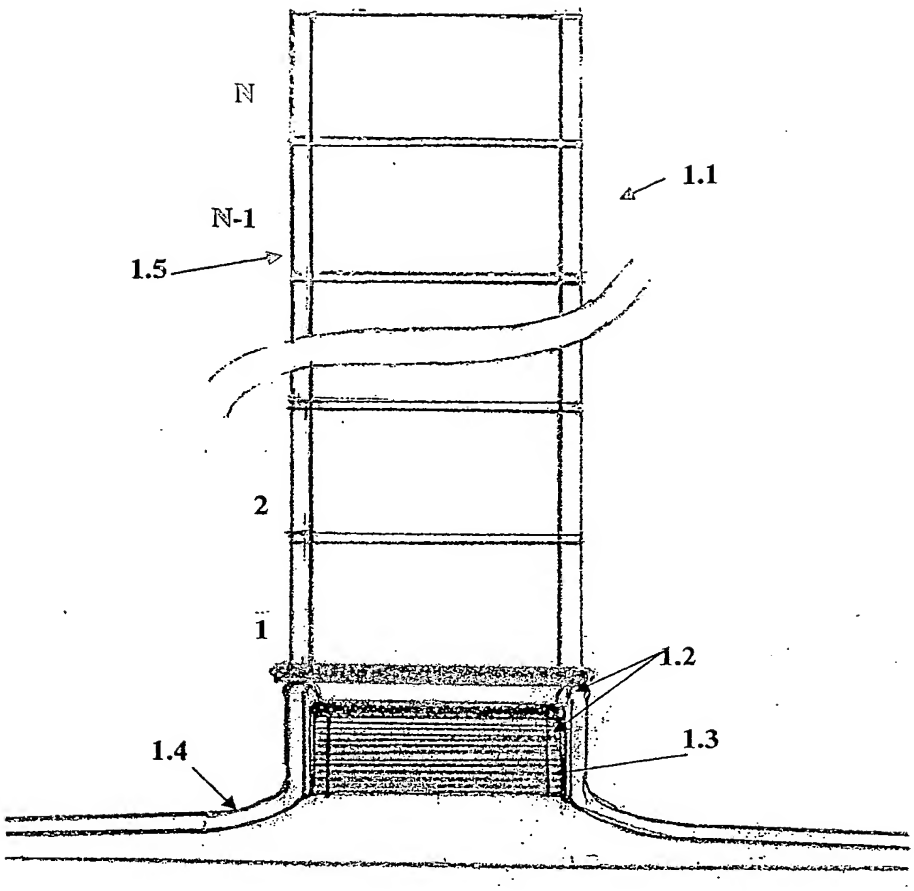

FIGURE 1 (*a*)

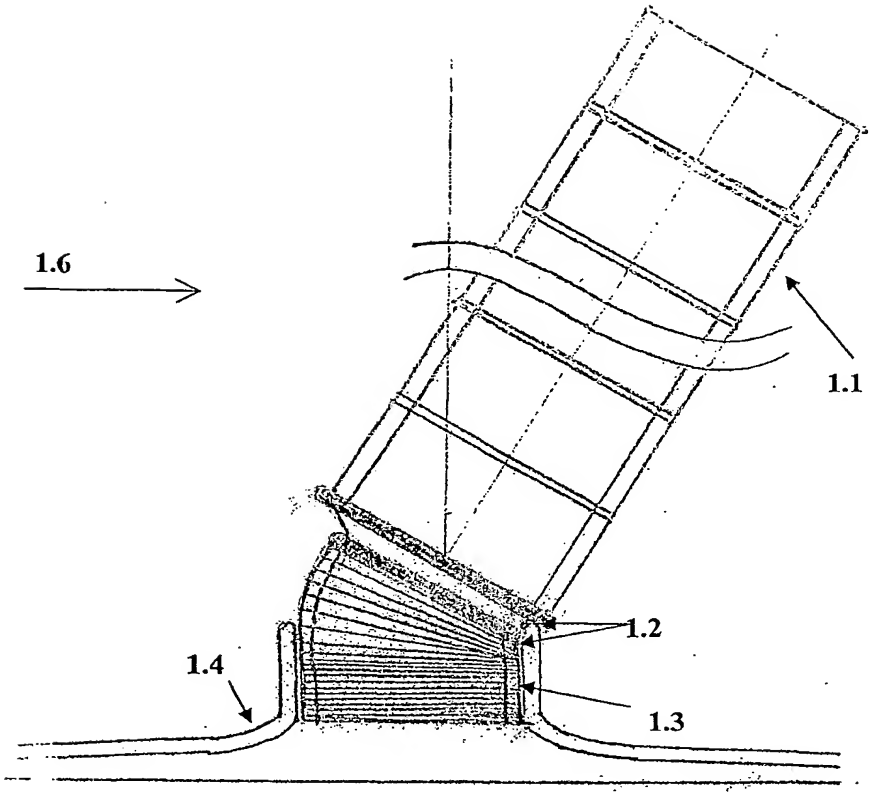

FIGURE 1 (b)

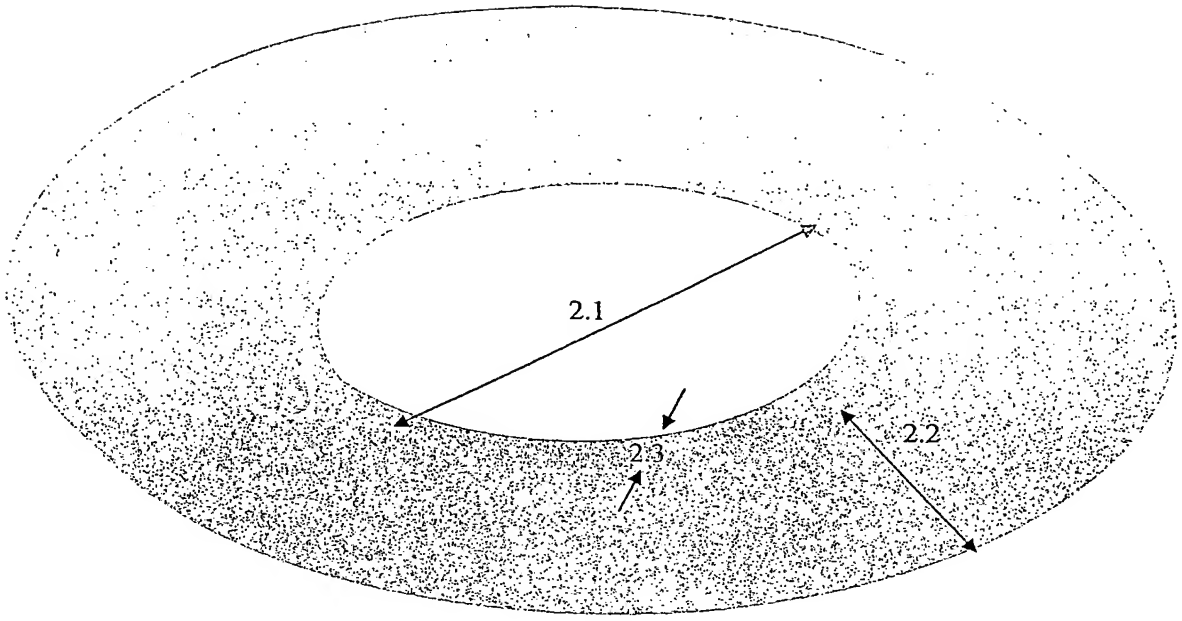

FIGURE 2

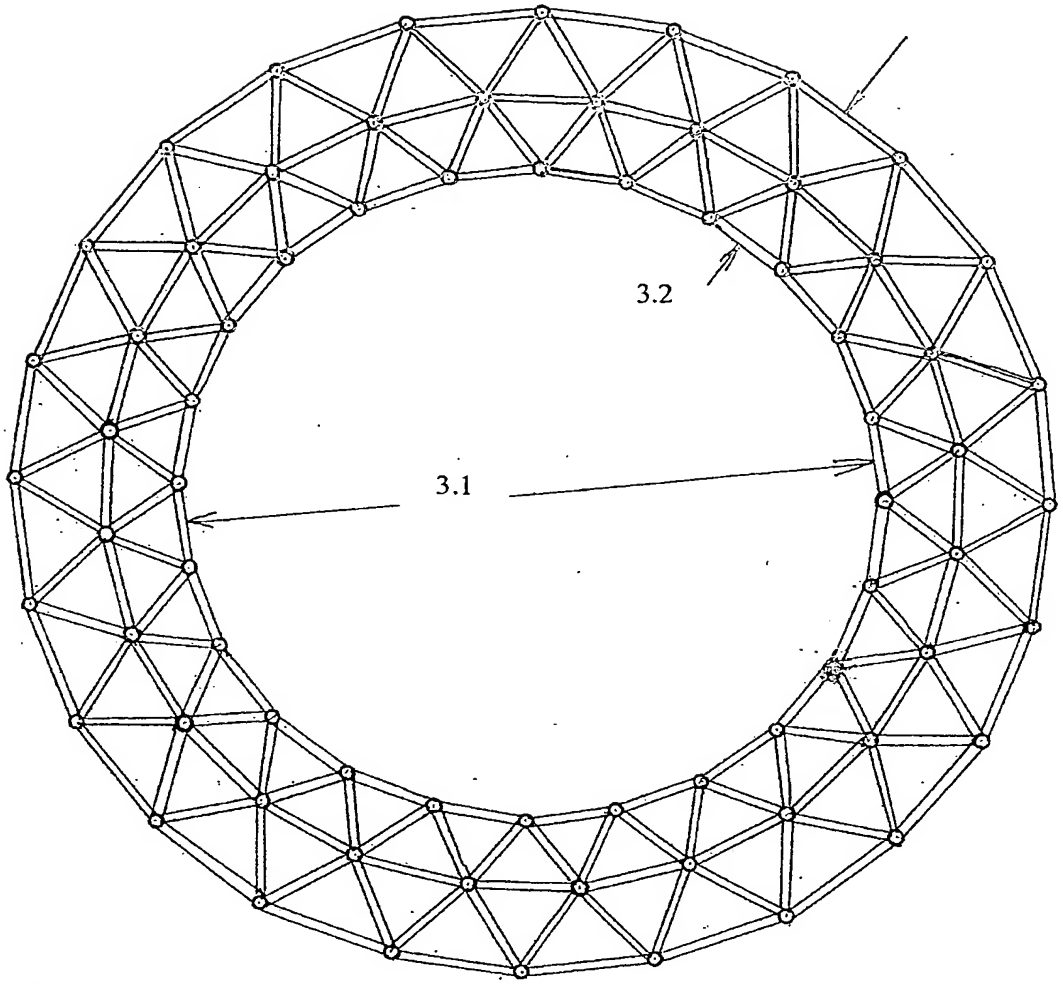

FIGURE 3